Analog Devices Wireless Sensor Network (WSN) Solutions

Industry WSN System Theory and Typical Architecture

Wireless sensor networks (WSNs) consist of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion, or pollutants. These sensors cooperatively pass their data through the network to a main location, the base station. Modern WSNs are bidirectional, enabling users to control the activity of the sensors.

WSNs are built of "nodes," from as little as a few to potentially thousands, with each node connected to one or more sensors. Each such sensor network node typically has several parts: a radiotransceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors, and an energy source, usually a battery or an embedded form of energy harvesting.

Communication Standards and Specifications

Several standards are currently either ratified or under development for wireless sensor networks. There are a number of standardization bodies in the field of WSNs. The IEEE focuses on the physical and MAC layers; the internet engineering task force works on layers 3 and above. Standards are used far less in WSNs than in other computing systems. However predominant standards commonly used in WSN communications include:

- ZigBee/802.15.4
- IEEE 802.11
- ISA100
- WirelessHART

Industry WSN System Design Considerations and Major Challenges

To have appropriate WSN system design, designers must consider many different system requirements including

- Power consumption constraints for nodes using batteries or energy harvesting
- Interoperability
- Ease of use
- Ability to cope with node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity nodes
- Scalability to large scale deployment
- Ability to withstand harsh environmental conditions
- Unattended operation

The main challenge in a WSN is to produce low cost, low power, and tiny sensor nodes. Energy is the scarcest resource of WSN nodes, and it determines the lifetime of WSNs. Another challenge is improving network system reliability in light of packet loss, which can occur through factors such as low power radio communication, variable transmission power, multihop transmission, noise, radio interference, and node mobility. With these characteristics, the quality of service (QoS) of the network is associated with parameters such as adjacent channel rejection, sensitivity, blocking, antenna efficiency, etc.

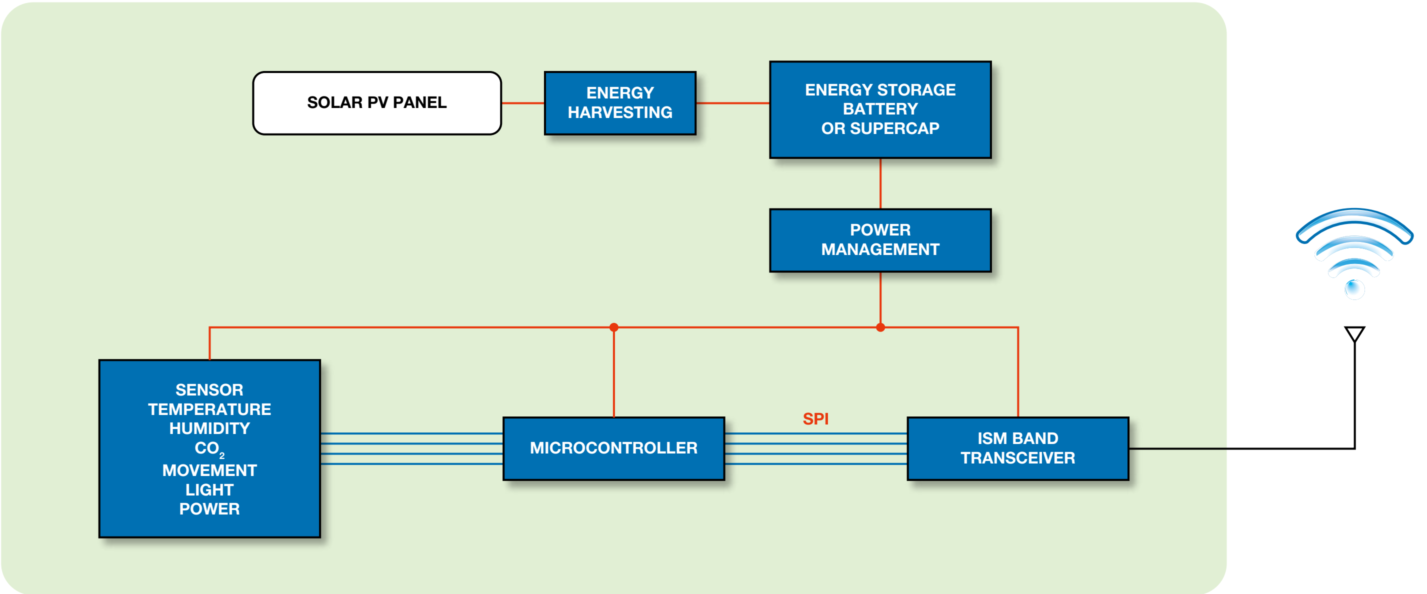
Resolution is not important, as 1% accuracy is often good enough. Full solution delivery includes RF software stacks, network protocol, and hardware, getting government approvals is important as end customer would like to buy an off the shelf solution.

ADI offers market tailored solutions to aid in the design process. These solutions feature our industry-leading technologies.

Total Solutions from ADI

Leverage ADI's sensor, signal processing, RF and power technology and expertise to high performance WSN system.

Main Signal Chain of WSN Node



Notes: The signal chains above are representative of a wireless sensor network application system. The technical requirements of the blocks vary, but the products listed in the table are representative of ADI solutions that meet some of those requirements.

Typical Applications

Street Lighting:
vehicle and passenger detection; lighting control

Infrastructure Monitoring:
vehicle and collision detection; lighting and video surveillance control

Smart Building:
temperature, humidity, PIR, CO_2, and vibration detection; lighting, ventilation, and alarm control

Asset Tracking:
barcode, temperature, humidity, and vibration detection; barcode tracking

Product Table List

Sensor	ISM Band Transceiver	Processor	Power Supply
ADT7420/ADXL362/AD7151/ADT75/ AD7745/ADMP441/SHT21/ADPD220/ AD7798/AD7799/AD7792/ADA4528-1	ADuCRF101/ADF7020/ADF7021/ ADF7241/ADF7242/ADF703x	ADuCRF101/ADuCM3xx/ADuC7026	ADP125/ADP160/ADP3330/ADP5054

Energy Harvesting	Amp	Mux	ADC
ADP5090	AD8236/ADA4692-2/ADA4692-4	ADG439F/ADG509F/ADG1208/ ADG1209/ADG1408/ADG1409	AD7781

Main Products Introduction

Part Number	Description	Features	Benefits
Sensors			
ADT7420	Temperature sensor	±0.5°C over range of –40°C to +125°C	High stability and reliability vs. thermistors No additional components and calibration required
ADXL362	3-axis MEMS accelerometer	±2 *g*/±4 *g*/±8 *g* with digital output; high resolution: 1 mg/LSB	Ultralow power
AD7745	CDC (capacitance-to-digital converter) for humidity sensing	Interfaces to single or differential floating sensors resolution down to 4 aF (that is, up to 21 ENOB)	High accuracy: 4 fF; high linearity: 0.01% temperature sensor on chip
AD7798/AD7799	Complete analog front ends for smoke detection	RMS noise: (AD7799) 27 nV at 4.17 Hz; 65 nV at 16.7 Hz (AD7798) 40 nV at 4.17 Hz; 85 nV at 16.7 Hz	Built in low noise, programmable gain, instrumentation amp, low power: 380 μA typical
AD7151	CDC for proximity sensing	Two independent capacitance input channels sensor capacitance (CSENS) 0 pF up to 13 pF sensitivity to 1 fF	Ultralow power; 2.7 V to 3.6 V, 100 μA
Processor			
ADuCM36x	Analog microcontroller with ARM® Cortex™-M3 core	32-bit ARM Cortex-M3 processor core; 128 k bytes of flash memory, 16 k bytes SRAM; single/dual single 24-bit ADC; offers up to 20 MIPS peak performance	High integration, low power consumption, precision ADC performance
ADuCRF101	Analog microcontroller + RF transceiver	32-bit ARM Cortex-M3 processor core; 128 k bytes of flash memory, 8 k bytes SRAM; 862 MHz to 928 MHz and 431 MHz to 464 MHz	A fully integrated data acquisition system incorporating high performance, multichannel ADCs, DACs, ARM7TDMI® core, and flash/EE memory on a single chip
RF			
ADF7242	ISM band transceiver	Frequency range (global ISM band) 2400 MHz to 2483.5 MHz; programmable data rates and modulation IEEE 802.15.4 compatible (250 kbps)	Low power consumption 19 mA (typical) in receive mode; high sensitivity (IEEE 802.15.4-2006) –95 dBm at 250 Kbps
ADF7023	ISM band transceiver	Frequency bands 862 MHz to 928 MHz; 431 MHz to 464 MHz low IF receiver with programmable IF bandwidths 100 kHz, 150 kHz, 200 kHz, 300 kHz	High receiver sensitivity (BER) –116 dBm at 1.0 kbps, 2 FSK, GFSK –107.5 dBm at 38.4 kbps, 2 FSK, GFSK very low power consumption
Power			
ADP160/ADP161/ ADP162/ADP163	LDO	Ultralow quiescent current, low dropout, linear regulators that operate from 2.2 V to 5.5 V and provide up to 150 mA of output current	Ultralow quiescent current iq = 560 nA with 0 μA load; iq = 860 nA with 1 μA load; initial accuracy: ±1% over line, load, and temperature: ±3.5%
ADP5054	Quad high current buck regulators	CH1/CH2: programmable 2 A/4 A/6 A sync buck regulator with low-side FET driver; CH3/CH4: 2.5 A buck regulator wide input range: 4.5 V to 15 V; 250 kHz to 2 MHz adjustable switching frequency	Small package, frequency synchronization input or output
ADP5090	Energy harvesting	Maximum power point tracking with harvester OCV sensing to extract the most energy from harvester best-in-class ultralight load (10 μA to 100 μA) efficiency reach <250 nA iq under deep sleep mode with programmable automatic switcher shutdown start at 380 mV input voltage with integrated charge pump	Support different energy storage with flexible programmability intelligently manage additional power path for optional primary cell backup battery
Mux			
ADG1408	4-channel/8-channel, ±15 V multiplexers	4.7 Ω maximum on resistance, up to 190 mA continuous current, rail-to-rail operation	Fully specified at ±15 V/+12 V/±5 V
Amp			
AD8236	In-amp	40 μA micropower (40 μA) INA with zero crossover distortion; 1 pA input bias current; high CMRR: 110 dB CMRR, G = 100; rail-to-rail input and output	Can operate on voltages as low as 1.8 V; excellent choice in battery-powered applications.

A wireless sensor node capable of sensing environmental variables or other types of inputs and wirelessly transmitting the pertinent information to other nodes or to a base station.

ADI WSN Platform

- Available
  - ADT75 Temp Sensor
  - ADXL362 Accelerometer
  - ADMP441 Microphone
  - SHT21 Sensirion Humidity Sensor
  - ADPD220 Photodiode. Ambient Light Sensor
  - Panasonic PIR Sensor
  - Connector for GSS CO2 Sensor
- CR2032 Coin cell battery (on back of board)
- 45 mm × 33 mm (1.78" × 1.3")
- Out-of-the-box compatibility with ADI WSN platform

What ADI Can Provide to Customers

- **WSN** Demo board
- **RF EVB** ADIsimRF, ADIsimSRD™
- **Power** EVB ADIsimPower
- **Processor** EVB emulation tools and software

For more WSN applications and products information, please visit:
www.analog.com/building-control-automation

For a complete WSN demo system, please visit:
www.analog.com/building-control-automation_Demo

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